

CLAIMS

1 1. An electrostatic actuator formed in a single layer comprising:
2 a stator formed in the layer comprising a first plurality of fingers;
3 a rotor formed in the layer comprising a second plurality of fingers,
4 wherein:

5 one or more of the fingers of the second plurality is between the fingers of
6 the first plurality, and

7 one or more fingers of the stator and rotor are positioned above a
8 conducting plane having the same potential as the rotor, and

9 one or more fingers of the rotor has a height less than or equal to one or
10 more fingers of the stator such that a vertical force is exerted upon the rotor, the
11 height measured from the bottom of the finger to the top of the finger.

1 2. The electrostatic actuator of claim 1 wherein the single layer is a
2 single layer of a wafer, the single layer comprising a semiconducting material.

1 3. The electrostatic actuator of claim 1 wherein the single layer
2 comprises a conductive material.

1 4. The electrostatic actuator of claim 1 wherein the single layer
2 comprises an insulating material.

1 5. The electrostatic actuator of claim 1 wherein the rotor further
2 comprises a central portion, the central portion forming part of a micro-optical
3 component.

1 6. The electrostatic actuator of claim 5 wherein the micro-optical
2 component has one or more filter elements, and wherein one or more of the
3 second plurality of fingers moves one or more of the filter elements.

1 7. The electrostatic actuator of claim 5 wherein the micro-optical
2 component attenuates or switches an input signal by rotation of the central portion
3 of the rotor.

1 8. The electrostatic actuator of claim 1, wherein a positive vertical
2 force is exerted upon one or more of the rotor fingers such that the rotor is
3 vertically moved from the plane of the stator.

1 9. The electrostatic actuator of claim 5 wherein a positive vertical
2 force is exerted upon one or more of the rotor fingers causing the central portion
3 of the rotor to rotate about an axis.

1 10. The electrostatic actuator of claim 5, wherein a positive vertical
2 force is exerted upon one or more of the rotor fingers and a negative vertical force
3 is exerted upon one or more of the rotor fingers such that the central portion of the
4 rotor is rotated about an axis.

1 11. The electrostatic actuator of claim 5 further comprising one or
2 more springs formed in the layer, the springs connected to the central portion of
3 the rotor.

1 12. The electrostatic actuator of claim 10, wherein the central portion
2 of the rotor is rotated about an axis aligned with the springs.

1 13. The electrostatic actuator of claim 1, wherein the conductive plane
2 is located below the fingers at a first side of the actuator, but not below the fingers
3 at a second side of the actuator.

1 14. The electrostatic actuator of claim 13, wherein a positive force is
2 created at the first side and a negative force is created at the second side.

1 15. The electrostatic actuator of claim 14, wherein the actuator pivots
2 about an axis located between the first and second side of the actuator.

1 16. The electrostatic actuator of claim 1, wherein the layer comprises
2 silicon, and the rotor and stator comprise the silicon.

1 17. The electrostatic actuator of claim 1 further comprising an
2 insulating layer below the silicon layer.

1 18. The electrostatic actuator of claim 17 wherein the fingers of the
2 stator and rotor are formed within the silicon layer by etching the silicon layer and
3 the insulating layer.

1 19. The electrostatic actuator of claim 13 wherein the insulating layer
2 is silicon dioxide.

1 20. The electrostatic actuator of claim 13 further comprising a silicon
2 layer below the insulating layer, and wherein the fingers of the stator further
3 comprise the insulating layer sandwiched between the silicon layer above and
4 below the insulating layer.

1 21. A method of forming an electrostatic actuator in a wafer
2 comprising a silicon substrate, an insulating layer on the substrate, and a silicon
3 layer having a height x on the insulating layer, the method comprising:

4 etching a trench having a depth y within the silicon layer; and thereafter
5 etching the silicon layer and the trench to the insulating layer to form a
6 rotor finger of height $x-y$ and a plurality of stator fingers of height x ; and
7 etching a portion of the insulating layer below the rotor and the stator
8 fingers.

1 22. The method of claim 21 further comprising depositing a
2 photoresist layer within the trench yet narrower than the trench prior to etching
3 the silicon.

1 23. The method of claim 23 further comprising etching the silicon
2 substrate from the bottom of the wafer to form a central portion of the rotor.

1 24. The method of claim 23 further comprising etching a portion of the
2 insulating layer to form a central portion of the rotor.

1 25. The method of claim 23 further comprising depositing a reflective
2 coating upon the central portion of the rotor.

1 26. The method of claim 21, wherein the insulating layer comprises
2 silicon dioxide.

1 27. An electrostatic actuator formed in a wafer having a first
2 conductive layer, a second conductive layer and an insulating layer between the
3 first and second conductive layers, the actuator comprising:

4 a stator comprising a first plurality of fingers, the fingers comprising a top
5 conductor formed in the first conductive layer, a bottom conductor formed in the
6 second conductive layer, and an insulator formed in the insulating layer;

7 a rotor comprising a second plurality of fingers, the rotor formed in the
8 second conductive layer, and wherein:

9 one or more of the fingers of the second plurality is between the fingers of
10 the first plurality, and

11 when a voltage is applied to the conductors of the stator a vertical force is
12 exerted upon one or more fingers of the rotor.

1 28. The actuator of claim 27 wherein the second plurality of fingers is
2 coplanar with the bottom conductor of the first plurality of fingers.

1 29. The actuator of claim 27 wherein the rotor further comprises a
2 central portion that is moved by the vertical force.

1 30. The actuator of claim 29, wherein the central portion is rotated
2 about an axis.

1 31. The actuator of claim 29, wherein the central portion is moved
2 substantially vertically from the substrate.

1 32. The actuator of claim 27 wherein the force moves a filter element
2 of a tunable filter.

1 33. The actuator of claim 27 wherein the force rotates a reflective
2 element to direct an input beam.

1 34. An electrostatic actuator formed in a insulating layer, the actuator
2 comprising:

3 a stator comprising a first plurality of fingers having an insulating portion
4 formed in the insulating layer, and a conductive portion upon the insulating
5 portion;

6 a rotor comprising a second plurality of fingers, the rotor formed in the
7 insulating layer, and wherein:

8 one or more of the fingers of the second plurality is between the fingers of
9 the first plurality, and

10 when a voltage is applied to the conductive portions of the stator fingers a
11 vertical force is exerted upon one or more fingers of the rotor.

1 35. The electrostatic actuator of claim 34 wherein the insulating
2 portion of the stator is coplanar with the rotor when the voltage is not applied to
3 the stator.

1 36. The electrostatic actuator of claim 34 wherein when the voltage is
2 applied the vertical force moves the rotor such that it is coplanar with the
3 conductive portions.

1 37. The electrostatic actuator of claim 36, wherein the rotor movement
2 pivots a micro-optical component connected to the rotor.

1 38. The electrostatic actuator of claim 37, wherein the rotor movement
2 pivots a mirror.

1 39. The electrostatic actuator of claim 37, wherein the micro-optical
2 component is a tunable filter.

1 40. An MEMS actuator comprising:

2 a stator having a plurality of fingers comprising an insulating material, and
3 a conductive material upon the insulating material;

4 a rotor having a plurality of fingers consisting of an insulating material,
5 and wherein:

6 the fingers of the rotor are inter-digital with the fingers of the stator, and

7 the insulating material of the stator is coplanar with the insulating material
8 of the rotor when no voltage is applied, and

9 when a voltage is applied to the conductive material of the stator, a force is
10 created moving the rotor upward towards the conductive material of the stator.

1 41. The MEMS actuator of claim 40, wherein the insulating material of
2 the rotor and the stator are formed within the same layer of a wafer.

3 42. The MEMS actuator of claim 40, wherein the insulating material of
4 the rotor and stator are formed from different wafers.